

**ARIZONA GAME AND FISH DEPARTMENT
HABITAT PARTNERSHIP COMMITTEE
HABITAT ENHANCEMENT AND WILDLIFE MANAGEMENT PROPOSAL**

Game Branch / HPC Project Number: 13-701

PROJECT INFORMATION

Project Title: Bighorn Sheep and Mountain Lions: A Study to Better Understand Their Relationships and to Help Guide Management Decisions

Region and Game Management Unit: Region 3 (GMUs 16A/18B) and Region 5 (GMU 33)

Local Habitat Partnership Committee (LHPC):

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Was the project presented to the LHPC?

YES[] NO[X]

Has this project been submitted in previous years? YES[] NO[X]

If Yes, was it funded? YES[] NO[] → **Funded HPC Project #(s):**

Project Type: Habitat use, effects of predation, predation management, population management, sheep transplant

Brief Project Summary: The goal of this project is to generate information that will guide decisions related to predation management, translocation strategies, and habitat management, with a focus on the following questions: 1) what is the influence of lion predation relative to other factors (e.g., disease, poor recruitment) influencing bighorn populations?, 2) what are the factors that increase bighorn sheep risk of lion predation?, and 3) what management actions may reduce the risk of lion predation among bighorn sheep? We will also examine how habitat characteristics, sheep behavior patterns and population dynamics like reproduction/recruitment and disease, and other environmental/geographic factors influence sheep population viability. We are requesting funding for 10 mountain lion GPS collars and 5 trap alarms to assist us in addressing objectives 2 and 3 at one of the study sites (in Region 3).

Big Game Wildlife Species to Benefit: Desert bighorn sheep (information gained will help guide predation management strategies, habitat management, translocation decisions, and related management decisions), mountain lions (information gained will guide predation management strategies, with the ultimate goal of reducing the need for management intervention), mule deer (information gained will increase our understanding of lion predation pressures on mule deer in bighorn sheep habitat)

Implementation Schedule (Month/Day/Year):

Project Start Date: October 1, 2013 (Bighorn sheep transplants in regions 3 and 5 will occur in November 2013, after which point we will begin monitoring and measuring different variables related to all objectives outlined below.)

Project End Date: July 1, 2017

Environmental Compliance:

NEPA Completed: Yes[] No[X] N/A[]

Projected Completion Date: _____

State Historic Preservation Office - Archaeological Clearance:

Yes[] No[X] N/A[]

Projected Completion Date: _____

Arizona Game and Fish Department EA Checklist: N/A[]

To be Completed by: Andrew Jones, Larisa Harding

Projected Completion Date: in progress

PROJECT FUNDING		
Special Big Game License Tag Funds Requested:	\$ 40,000.00	
Cost Share or Matching Funds:	\$ 181,478.41 (Federal funding from Research Branch for FY14 [July 2013-June 2014]) This does not include Federal Aid funds that we will contribute in FY15-FY18, and does not include resources invested by AZGFD Regions (bighorn sheep captures, translocation, bighorn sheep radio collars)	
Total Project Costs:	\$ 221,478.41	
PARTICIPANT INFORMATION		
Applicant (please print): Larisa Harding (Terrestrial Research Prgm Mngr) Andrew Jones (Wildlife Specialist)	Address: Arizona Game and Fish Department 5000 W. Carefree Highway Phoenix, AZ 85086	E-mail: lharding@azgfd.gov, ajones@azgfd.gov
Telephone: 623-236-7301		Date: 8/30/2013
AGFD Contact and Phone No. (If applicant is not AGFD personnel):		
Project has been coordinated with: Region 3 Wildlife Program Manager (J. Pebworth) and Game Specialist (E. Butler); Game Branch Chief (B. Wakeling) and Big Game Management Supervisor (A. Munig); Region 5 Wildlife Manager (Ben Brochu).		

NEED STATEMENT – PROBLEM ANALYSIS:

Mountain lions (*Puma concolor*) and bighorn sheep (*Ovis canadensis*) are native species that have shared a long history in the Southwest and most of western North America. Their predator-prey relationship dates back thousands of years and, although deer are typically recognized as the primary prey of mountain lion, bighorn sheep are also known to be a key prey item. However, lion predation on bighorn sheep has caused concern in past years because of declining bighorn sheep populations and the fear that lions may drive populations to extinction. Predation by mountain lions has been identified as a leading cause of mortality in some populations, and there is now a growing consensus that lion predation can limit populations and potentially drive small populations to extirpation. Previous studies have examined the potential influence of lion predation on population viability with computer simulations using empirical data, as well as empirically exploring the effectiveness of lion removal on bighorn sheep population recovery. However, much of this predator-prey relationship remains poorly understood. One underlying question that remains is why some bighorn sheep populations are threatened by lion predation when they have evolved with an array of potential predators, including mountain lions, and other populations are able to sustain lion predation. Attempts to better understand this relationship can be complicated by several factors. First, bighorn sheep populations can be negatively influenced by other factors such as disease and drought, and the effect of these factors is not always easily detected. Disease can weaken animals, making them more susceptible to predation, yet predation may be detected as the proximate cause of death upon investigation of a mortality site. Drought and other factors that influence forage and habitat quality may also make animals more

susceptible to predation by weakening animals or causing them to choose more risky habitat in search of food and water. In addition, habitat modification may influence a bighorn sheep's risk of lion predation.

For instance, fire suppression has been proposed as a potential factor influencing bighorn sheep habitat quality and predation risk. Addition of artificial water sources has also been proposed as having the potential to increase predation risk by facilitating shifts in distribution of lions or other prey species such as deer.

An increased understanding of these relationships will allow the Department to use limited resources more efficiently and effectively by informing the selection of appropriate predation management actions. These actions, which could include diverse activities such as habitat restoration, manipulation of water availability, and manipulation (through harvest, translocation, etc.) of prey species, in addition to selective lethal predator removal, have the potential to reduce the negative effects of predation on prey populations, therefore reducing long-term costs to the Department.

Wildlife managers recognize the value of closely monitoring bighorn sheep populations, but these efforts are often challenged by a lack of resources. Comprehensive annual surveys are not always feasible, and investigations of mortalities are sometimes delayed due to competing priorities. In addition, and perhaps most importantly, the influences of disease, drought, and habitat modification, such as changes in recruitment and habitat use, may be subtle and difficult to discern without systematic data collection and analysis. In a recent information assessment of research needs, the Department identified the need for a project on the relationships between bighorn sheep and mountain lions as one of their top priorities. The Department has, in recent years, adopted an adaptive management approach to managing lions in bighorn sheep habitat. Although this approach allows flexibility in responding to lion predation, and it may increase our knowledge base, it has not been designed specifically to address the underlying questions discussed above. We therefore propose a research project that will augment and inform the Department's ongoing and planned bighorn sheep and mountain lion management actions.

PROJECT OBJECTIVES:

The objectives of this project are multifold. We have discussed the following five objectives with with regions 3 and 5, and have coordinated with each region to use bighorn sheep GPS data from reintroduced bighorn sheep in the Catalina Mountains (reintroduction planned for Nov 2013) and translocated bighorn sheep in the Peoples Canyon area in Region 3 (translocation planned for Nov 2013) to address objectives 1, 2, and 5. We propose to address objectives 3 and 4 only at the Region 3 study site. The funding requested in this proposal is specifically to support objectives 3 and 4 in Region 3 only (please see below for proposed approach).

Objective 1:

Examine which factors put bighorn sheep at increased risk of lion predation. These may include:

- Habitat use in relation to:
 - Topography (slope, ruggedness, aspect)
 - Vegetation type and cover (horizontal visibility)
 - Habitat conversion or modification (e.g., from invasive species, fire)
 - Distance to water
- Group size or composition
- Season
- Time since release
- Age/Sex
- Distance to human activities
- (Source population, if future translocations use different source populations)

Management implication: To inform future decisions on transplant site selection, group size for transplants and augmentations, habitat restoration, management of water developments, and management of recreational activities.

Proposed research approach: We will use GPS-collar data to monitor bighorn sheep habitat use and overlay locations on environmental layers in GIS framework to characterize habitat use patterns. All sheep in the Catalina Mountains will have collars in 2013. Region 3 intends to move ≤ 40 sheep from GMU 15D to 16A, and we have purchased 16 collars for those bighorn sheep to supplement 8 collars purchased by Game Branch. We will conduct field work to monitor sheep group size and composition, and to collect habitat measures (e.g., horizontal visibility, vegetation measures) to verify habitat covariates at sheep localities and random points and then run risk assessment analyses using established methods such as those often used in human epidemiological studies (e.g., Cox proportional hazards models).

Objective 2:

Describe bighorn sheep habitat selection and how this changes with time (after translocation/reintroduction). This may include the following covariates:

- Topography (slope, ruggedness, aspect)
- Vegetation type and cover (horizontal visibility)
- Habitat alteration/disturbance
- Distance to water
- Distance to human activities
- Distance to other species (e.g., burros, deer) if distribution of these species is known in the study area.

Management implications: To use sheep habitat selection to inform management decisions related to land management (habitat manipulation, recreation, roads) and future translocations. For instance, are the bighorn sheep selecting habitat consistent with presumed predator avoidance strategies? Are they selecting habitat in areas with high horizontal visibility or in relation to human activities? Can habitat restoration and/or fire management be used to reduce risk of lion predation? Is there a need to manage burros or deer relative to bighorn sheep or alter recreation or other human activities to benefit bighorn sheep?

Proposed research approach: Monitor bighorn sheep as in Objective 1 and analyze locational data via established habitat selection methods (such as but not limited to utilization distributions) and a moving window approach to look for temporal shifts in habitat selection.

Objective 3 (to be addressed in Region 3 only):

Describe lion social structure and space use within the study area, and document how the following characteristics change in relation to (potential future) lion removal and time since bighorn sheep population augmentation.

- Density
- Sex ratio
- Age structure
- Home range characteristics (size, overlap, temporal shifts)

Management implications: To increase our understanding of long-term impacts of lion removal on lion population dynamics. To provide data on poorly known lion response to removals, and ultimately, provide data to inform decisions related to lion management. In addition, information may be gained on lion movement to and from other GMUs, mountain ranges, or regions (e.g., Region 4).

Proposed research approach: Attempt to collar and monitor all lions within the study area with GPS technology. Also conduct ground surveillance (e.g., cameras, track surveys) to monitor for uncollared lions and/or uncollared offspring. While demographics (age structure, sex ratio) of any lions removed

will be readily apparent, this approach will provide information on other resident and transient lions. In addition, minimum density will be estimated from the maximum number of animals known to be alive on the study area. Data will be examined to track temporal changes/shifts in sex ratios, age structure, and density of lions. This will involve several seasons of lion trapping to adequately sample lion population and to detect changes in lion population characteristics over time.

Objective 4 (to be addressed in Region 3 only):

Describe mountain lion prey selection and if/how it changes over time.

- Proportion of kills comprised of bighorn sheep
- Proportion of lions killing bighorn sheep and proportion not known to kill bighorn sheep
- Relationship between predation rates and lion age/sex

Management implications: To inform lion management relative to reducing bighorn sheep predation and to provide data to inform decisions related to lion management.

Proposed research approach: Use lion GPS clusters to identify possible kill sites, investigate and document species killed/preyed on. Given that lions in this area likely prey on deer and burros, as well as bighorn sheep and other species, analyze data for trends in diet shifts and to determine/track long-term prey selection (deer and other species vs. bighorn sheep) after augmentation of the bighorn sheep population.

Objective 5:

Determine the proportion of bighorn sheep mortality due to lion predation and other mortality factors, and examine the relative influence of specific mortality causes (including lion predation) on viability of the bighorn sheep population (in comparison to recruitment and other sources of mortality).

Management implications: To estimate the relative importance of cause-specific mortality (including lion predation) in limiting the bighorn sheep population, and to help guide decisions related to lion management (e.g., removals). To quantitatively examine the relative importance of factors influencing viability of the bighorn sheep population.

Proposed research approach: Conduct prompt investigation of all mortality sites (in collaboration with regional staff), and assign probable cause of death using specific field criteria. Conduct field necropsy and health sampling when feasible, and collect data on mortality site characteristics (these latter data will also help inform Objective 1). Locate and observe female bighorn sheep during key seasons to determine recruitment rates. Conduct a quantified demographic analysis to determine which demographic parameters most influence population viability.

PROJECT DESCRIPTION AND STRATEGIES:

We have briefly described each component of this study and expected methodologies to address each above. As should be evident from these descriptions, this project will be field-intensive and will require close monitoring of collared bighorn sheep and lions. We will be working in bighorn sheep habitats in the Catalina Mountains in Region 5 (GMU 33) near Tucson and in the Peoples Canyon area of Region 3 (GMU 16A, 18B). Due to the Catalina Advisory Committee's concern about collaring mountain lions as part of the Catalina bighorn sheep reintroduction project, we will not collar any lions in the Catalina study area, but we will collar lions in the Peoples Canyon site. We will conduct detailed habitat analyses at both sites. We will conduct a review and analysis of existing Department bighorn sheep data to incorporate all available Department data into our analyses, to augment field data that we will collect. Close coordination with regions 3 and 5 has afforded us the opportunity to make use of planned regional activities (a reintroduction in Region 5 and a planned translocation in Region 3) to address one of the Department's top management information needs, and to increase our understanding of the relationship between bighorn sheep and mountain lions. This coordination will make use of multiple Department

investments to result in overall cost saving, and allow us to pursue objectives at two sites. We have purchased collars for sheep in Peoples Canyon and would like to get additional collars for lions, as we currently have limited funding for lion collars. Region 3 is actively working on an adaptive management plan for the Peoples Canyon area and will incorporate lion management in their plan, and data from these collars could help inform predation management decisions. In addition, any lions that move from Region 3 into Region 4 nearby would fall under their adaptive management plan. We have coordinated extensively with both Regions 3 and 5, the Game Branch, and Department Game Specialists to ensure that our proposed objectives would adequately address the needs of the respective Regions and Game management information needs. Both Regions have or are actively pursuing the necessary NEPA, SHPO, and EAC clearance to move sheep, and we will complete our own EA Checklist before starting this proposed research.

PROJECT LOCATION:

In Region 3, the bighorn sheep translocation and this proposed research will occur in the southeast corner of GMU 16A and southwest corner of GMU 18B (in T13N, R10W). The study area (see Figure 1, outlined in yellow) is located primarily north of Alamo Lake and the Santa Maria River, south of Wikieup, AZ, west of Highway 93 and Baghdad, AZ, and east of Signal, AZ and the Big Sandy River.

In Region 5, bighorn sheep will be released at several sites primarily into the Pusch Ridge Wilderness area (see Figure 2, outlined in yellow) east of Tucson in the Catalina Mountains (chiefly in T12S, R14-15E). The habitat surveys we conduct will focus chiefly on those areas used and occupied by sheep.

LAND OWNERSHIP AT THE PROJECT SITE(S):

The majority of our study area in Region 3 is public land managed as BLM Wilderness and State Trust Lands. The Pusch Ridge Wilderness area in Region 5 is public land managed by the Coronado National Forest, Santa Catalina Ranger District. Other areas nearby where desert bighorn sheep may relocate are situated on State and US Forest Service land.

IF PRIVATE PROPERTY, IS THERE A COOPERATIVE BIG GAME STEWARDSHIP or LANDOWNER AGREEMENT BETWEEN THE LANDOWNER AND THE DEPARTMENT?
YES[] NO[] N/A[X]

HABITAT DESCRIPTION:

The study area in Region 3 contains mostly a mixed palo verde-cactus vegetation cover, with creosote bush-bursage and mixed juniper communities intermingled. Topography varies from low hills to deep, wide canyons (e.g. Burro Canyon) to steeper, more rugged country. Elevations range up to ~1,400 m. The Catalinas range up to ~2,400 m, though elevations in the Pusch Ridge Wilderness area are lower. Topography varies from rolling hills and high benches to steep, rugged cliffs, ridges and canyons, and vegetation varies from an upper Sonoran desert scrub assemblage to oak woodlands and ponderosa pine at higher elevations.

ITEMIZED USE OF FUNDS:

Special Big Game License Tag Funds

Requested amount \$40,000.00

Line items:

Included costs/collar:

TGW-4560-3 carnivore collar \$2,850.00

Estimated airtime for life of VHF (~27 months) on collar (incl. transmission fees, activation fee, monthly service fee	~\$700.00
Total for 10 GPS/Globalstar telemetry collars:	\$35,500.00
GPS data conversion software (required, one-time fee)	\$495.00
Collar GPS downloading cables, adaptors (2 sets)	\$405.00
1 satellite trap transmitter	~\$2,500.00
4 trapsite VHF transmitters	~\$1,100.00

Cost Share or Matching Funds (for volunteer labor rates please refer to the worksheet below)

Total from W-78 Federal Aid funds	\$181,478.41
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Line items:

Personnel (1 Wildlife Specialist, 1 Biotechnician, fulltime)	\$92,956.00
16 bighorn sheep GPS/Globalstar collars	\$48,417.41
Perdiem (for 2 people, \$30/day, 182 days)	\$10,920.00
Mileage, housing	\$17,785.00
3 lion collars (~\$3,550.00/collar, as above)	\$10,650.00
3 trapsite VHF transmitters	~\$750.00

LIST COOPERATORS AND DESCRIBE POTENTIAL PARTICIPATION:

Region 3 and Region 5 Game Specialists and Wildlife Managers to capture/relocate sheep and help respond to sheep mortalities; Region 4 Game Specialists have agreed to train and assist in lion capture/handling. BLM and USFS cooperators may assist where necessary for land access issues, and Advisory Committee to Catalina reintroduction project represents an assortment of special interest groups (e.g., Center for Biological Diversity, Sierra Club, Desert Sheep Society) working for the success of the Catalina project and we have been coordinating our objectives with them to ensure we have their support.

WOULD IMPLEMENTATION OF THIS PROJECT ASSIST IN PROVIDING, MAINTAINING, OR FACILITATING RECREATIONAL ACCESS?

YES[] NO[X] N/A[]

PROJECT MONITORING PLAN: Bighorn sheep and lions will be monitored via satellite GPS collars. Lion trapsites will be actively monitored when they are open and operational, and both sheep and lions will be monitored on the ground and from the air (with annual sheep surveys each fall from Region).

PROJECT MAINTENANCE:

No maintenance is required.

PROJECT COMPLETION REPORT TO BE FILED BY: Wildlife Specialist (Andrew Jones) and Terrestrial Research Program Manager (Larisa Harding)

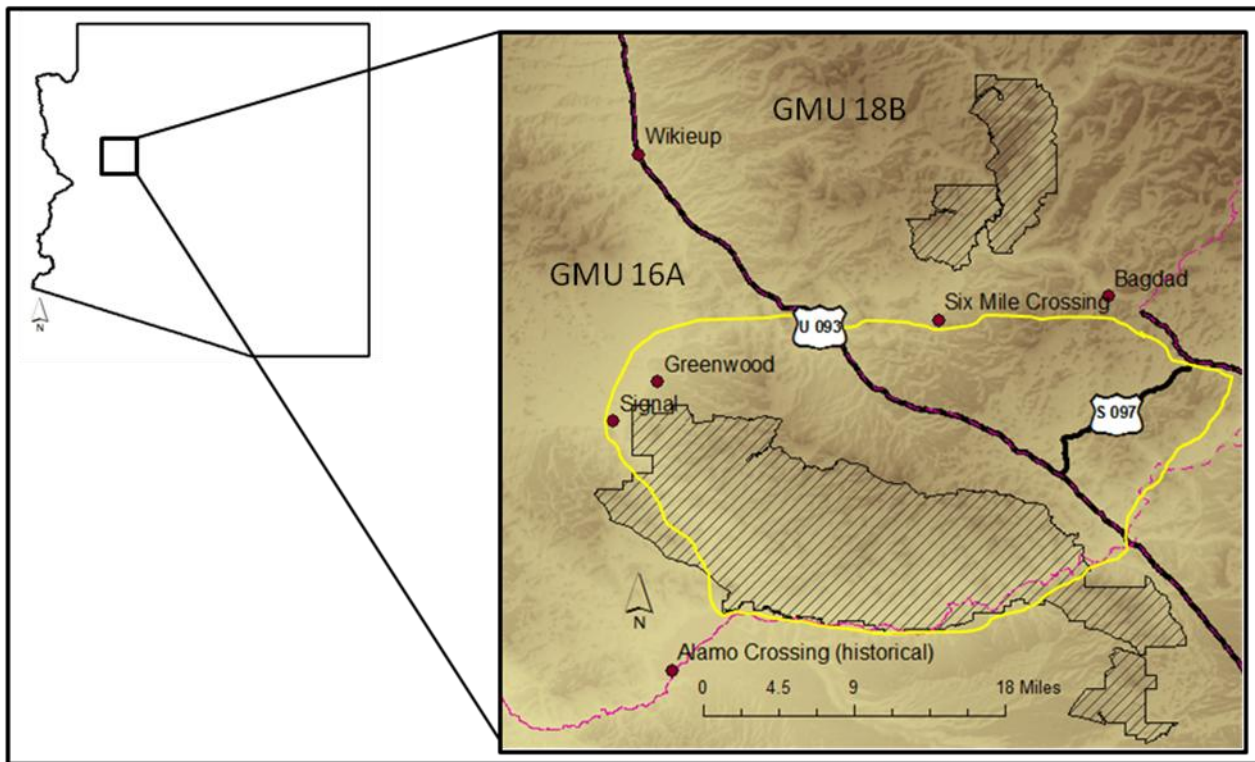


Figure 1. Bighorn sheep transplant area near People's Canyon and Burro Canyon in Region 3. Hatched areas are BLM Wilderness, yellow outline is primary target release area for bighorn sheep, and dashed pink lines distinguish Game Management Units 16A and 18B.

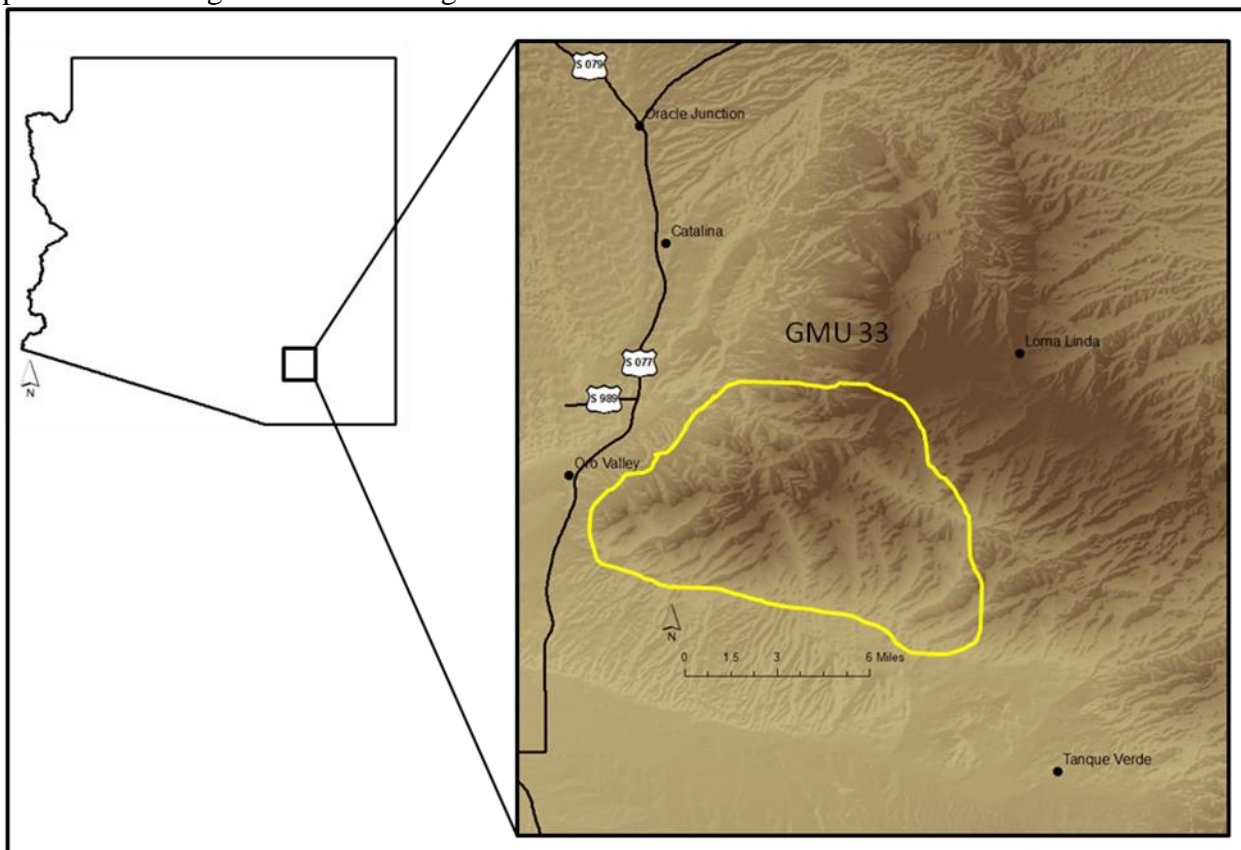


Figure 2. Proposed bighorn sheep reintroduction area on Pusch Ridge Wilderness area (outlined in yellow) in GMU 33 of Catalina Mountains northeast of Tucson, AZ.